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ML experts ensure Air Force flies safe and affordably

by Timothy Anderl, Materials and Manufacturing Directorate

WRIGHT-PATTERSON AFB, Ohio – When aircraft materials or systems malfunction, materials experts from the Air Force Research Laboratory's Materials and Manufacturing Directorate try to determine what went wrong and work with their partners in aviation to find safe, reliable, and affordable solutions.

The directorate's Materials Integrity Branch is comprised of experts in electronics failure analysis, structural failure analysis, nondestructive evaluation, coatings, composites, electrostatic discharge, and paints, sealers and adhesives. Over the years, this team has been called upon to solve hundreds of materials challenges.

Aircraft wiring is one example. More than 20 miles of electrical wire snakes through a jet fighter. A bomber contains more than 150 miles. This wiring provides a lifeline that connects electrical systems with the components used to operate the aircraft's flight navigation and communication systems. A short or failure anywhere in the wiring can have severe consequences.

SHUTTLE WIRING — George Slenski (right) studies space shuttle wiring at the request of the National Aeronautics and Space Administration (NASA). Slenski, who worked as part of an independent assessment team, evaluated space shuttle maintenance practices and briefed them to NASA management. @

"The wire bundle insulation in many of the older aircraft, under certain conditions, can fail catastrophically," George Slenski, the branch's Electronic Failure Analysis Group leader explained. "An electrical short can rapidly propagate into adjacent wiring, causing the loss of multiple systems. At times, this has led to major damage to aircraft wiring and required aircrews to declare emergencies. Most times the wiring failures result in aircraft downtime, which can greatly increase the maintenance burden that results from the troubleshooting, and repair of aircraft."

Because the service life of many Air Force aircraft are pushed to extreme limits, the group's experts have vigorously battled a number of problems caused by aging wiring.

The group's battle with aging wiring isn't limited to military and commercial aircraft. In 1999, the space shuttle lost two of its main engine controllers five seconds after it launched (back-up systems allowed the shuttle to complete its mission). The shuttle program was grounded and the National Aeronautics and Space Administration (NASA) requested Slenski's input as part of an independent assessment team that evaluated space shuttle maintenance practices.

Experts from the wiring assessment team identified several issues that required immediate action. They inspected two of the shuttles, identifying ways to determine aged wire damage and steps to be taken when examining the entire shuttle fleet. They also identified pre-existing damage that may have been caused by earlier maintenance actions. The team briefed NASA management on their findings, which resulted in the wiring problems being corrected and the shuttle fleet returning to flight.

The Failure Analysis Group solves these problems related to aging wiring by studying the way a material might fail on the aircraft, and how it could cause additional damage to the wiring. However, Slenski said that the toughest part of his job begins when the analysis of a problem is complete.

"We have to clearly communicate the critical elements of our analysis to the group responsible for preventing possible future incidents. We also attempt to communicate in general terms our findings to the aerospace community through published reports and various briefings and presentations," Slenski said.

In addition to extensive in-house work in wiring, the group collaborated with the aerospace community, including the Navy, the Federal Aviation Administration (FAA) and NASA, to develop and transition an insulation system that increased thermal stability, mitigated arc propagation, improved the wire's durability, and made the wire more flexible. Recognizing the need for the improved insulation material in both new and aging aircraft, Slenski and his fellow researchers worked hard

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to convince the aerospace industry that production of this material was in their best interest.

"This improved insulation system is now being used on many military and commercial aircraft, including our newest, most advanced fighters," Slenski said.

Working with other Department of Defense (DoD) branches and peers in the commercial aerospace field is not uncommon. The group has worked with the Army, Navy, the Departments of Justice and Transportation, Boeing Company, and many others. Within the Air Force, the group frequently provides support for Air Logistic Centers and System Program Offices.

The group's efforts to communicate wiring related issues and to generate awareness of electronic failure analysis has established the AFRL as the national research and development facility to turn to for solutions. In fact, senior officials from the DoD and the White House Office of Technology and Policy requested that they participate on a team for defining national strategy in this critical area.

"The program that the White House has initiated will allow us to coordinate with the other DoD services, FAA and NASA to establish a national strategy for dealing with these issues," Slenski said. "This collaboration will help us to improve reliability and reduce the ownership costs of aircraft systems, proactively develop better diagnostic and prognostic tools for managing wiring, and to develop better materials for aircraft wiring.

"Taking these steps in the right direction together will ultimately decrease the amount of maintenance time required to maintain military and commercial aircraft and will improve our mission readiness," Slenski said. **@**